DOCUMENT RESUME

ED 111 740 SO 008 593

AUTHOR Dansereau, Donald F.; And Others
TITLE Effective Learning Strategy Training Program: Development and Assessment. Final Report for Period January 1974-May 1975.
INSTITUTION Air Force Human Resources Lab., Lowry AFB, Colo. Technical Training Div.; Texas Christian Univ., Fort Worth. Inst. for the Study of Cognitive Systems.
REPORT NO AFHRL-TR-75-41
PUB DATE Jun 75
NOTE 82p.; For related document, see SO 008 594 and 595

EDRS PRICE MF-$0.76 HC-$4.43 Plus Postage
DESCRIPTORS Comprehension; Educational Assessment; *Learning Processes; Learning Theories; *Mnemonics; *Program Development; Psychology; Questioning Techniques; Retention; *Retention Studies; Social Science Research; Social Sciences; *Training; Visualization

ABSTRACT

Potentially effective and trainable learning strategies were identified by analysis of a specially developed learning strategy inventory and a survey of educational and psychological review literature. Four aspects of the learning process suggested the usefulness of special training: identification of important or unfamiliar material, applications of techniques for the comprehension and retention of this information, efficient retrieval of information, and skill in coping with distractions during the foregoing processes. A training program was developed for teaching selected specific strategies, including comparison of the three alternative comprehension/retention strategies (referred to as connection techniques) of paraphrasing, question answering, and the use of visual imagery. The results indicated that minimal strategy training showed significant results in long-term retention, although no reliable differences were found in immediate testing. Further refining of the techniques was recommended. An effective strategy training program suitable for implementation in technical training was created, modified, and assessed. (Author)

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AFHRL-TR-75-41

AIR FORCE HUMAN RESOURCES LABORATORY

EFFECTIVE LEARNING STRATEGY TRAINING PROGRAM: DEVELOPMENT AND ASSESSMENT

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June 1975
Final Report for Period January 1974 – May 1975

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This final report was submitted by the Institute for the Study of Cognitive Systems, Department of Psychology, Texas Christian University, Fort Worth, Texas 76129, under contract F41609-74-C-0013, project 1121, with Technical Training Division, Air Force Human Resources Laboratory (AFSC), Lowry Air Force Base, Colorado 80230. Dr. Gerard M. Deignan, Instructional Design Section, and Dr. Ronald W. Spangenberg, Instructional Technology Branch, shared the contract monitorship.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFHRL-TR-75-41

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE *(and Subtitle)*: EFFECTIVE LEARNING STRATEGY TRAINING PROGRAM: DEVELOPMENT AND ASSESSMENT

5. TYPE OF REPORT & PERIOD COVERED: Final, January 1974 – May 1975

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): Donald F. Dansereau, Gary L. Long, Barbara A. McDonald, Tomme R. Actkinson, Alice M. Ellis, Karen Collins, Stephen Williams, Selby H. Evans

8. CONTRACT OR GRANT NUMBER(s): F41609-74-C-0013

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Institute for the Study of Cognitive Systems, Department of Psychology, Texas Christian University, Fort Worth, Texas 76129

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62703F, 11210119

11. CONTROLLING OFFICE NAME AND ADDRESS: Hq Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235

12. REPORT DATE: June 1975

13. NUMBER OF PAGES: 80

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*: Technical Training Division, Air Force Human Resources Laboratory, Lowry Air Force Base, Colorado 80230

15. SECURITY CLASS. *(of this report)*: Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT *(of this Report)*: Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*:

18. SUPPLEMENTARY NOTES: Other technical reports documenting work unit 11210119 are: AFHRL-TR-74-70, AFHRL-TR-75-40, AFHRL-TR-75-46, AFHRL-TR-75-47, and AFHRL-TR-75-48.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*:
learning
learning strategies
learning deficits
learning process
diagnosing learning
retention
comprehension
coping with distraction
retrieval training

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*:

Potentially effective and trainable learning strategies were identified by an analysis of a specially developed learning strategy inventory and a review of educational and psychological review literature. Four aspects of the learning process suggested the usefulness of special training. These were the identification of important or unfamiliar material, the applications of techniques for the comprehension and retention of this information, the efficient retrieval of information and the skill in coping with distractions during the foregoing processes. A training program was developed for teaching selected specific strategies, including the three alternative comprehension/retention strategies of paraphrasing, question-answering, and the use of visual imagery, in such a way as to compare the three alternative connection techniques. The results indicated that minimal strategy training showed significant results in

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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Item 20 Continued:

long term retention, although no reliable differences were found in immediate testing. Further refining of the techniques was recommended. An effective strategy training program suitable for implementation in technical training was created, modified, and assessed.

SUMMARY

Problem

Academic performance differences within equal ability groups have been correlated with the way students select and use differing information processing strategies. In fact, information processing or learning strategies may be more fundamental determinants of learning performances than actual abilities. Further, training in how to select and use more efficient techniques and strategies for selecting, storing, manipulating and outputting information should enhance learning performance. Sources of information and strategies for processing information presently used by high and low ability students can be related to student performance, thus identifying strategies which can be used by the student to improve his performance. These validated information processing strategies can be used to help improve student performance in the Air Force training system. The initial requirement is based on the needs within the Advanced Instructional System to identify performance facilitating strategies. The strategies should enable improved learning performance and transfer of training to the job situation.

Approach

This project has involved three basic steps: the identification of potentially effective and trainable learning strategies, the development of methods for teaching these strategies to students, and the assessment of the effectiveness of the strategies in the context of academic-like tasks.

The identification of effective strategies has been accomplished using information gathered from a review of the educational and psychological research literature dealing with strategies, and from an analysis of responses to the specially developed Learning Strategy Inventory (see Dansereau, Long, McDonald, & Actkinson, 1975.) The results of research with the Inventory indicated that students could be profitably trained on four aspects of the learning process: the identification of important, unfamiliar, and difficult material, the application of techniques for the comprehension and retention of this identified material, the efficient retrieval of this information under appropriate circumstances, and the effective coping with internal and external distractions while these other processes are being employed.

After these four areas of needed improvement were identified, specific strategies relating to each of these aspects were extrapolated from the educational and psychological literature. The process of applying techniques for enhanced comprehension and retention was believed to be most critical, consequently three alternative comprehension and retention techniques or strategies were extrapolated

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(paraphrasing, question-answering, and the use of visual imagery). Methods for training the strategies related to the four aspects of the learning process were developed and combined in an integrated, prototypical training program.

As a basis for assessment of this program, three groups of students were given the strategy training program; the only difference between these groups was in the type of comprehension and retention technique with which they were provided (paraphrase, question-answer, or images). A fourth group (control) did not receive training, but was asked to respond to the dependent measures.

Results

The results of this study indicated that the training program dramatically improved long term retention of academic-like material. On one dependent measure, the training groups performed at a level that was approximately 55% higher than that of the control group. Minimal strategy training showed significant results in long term retention, although no reliable differences were found in immediate testing.

Conclusions

Analysis of the results suggest that the maximum effectivess of the connection techniques was not achieved with the short training program used. The paraphrase and imagery connection techniques training should be further refined while the question-answer technique should be dropped from future consideration as it did not show superior results to the other two techniques in any aspect.

In summary, this project has proven to be very successful, an effective strategy training program has been created, modified, and assessed. We feel this training program is sufficiently effective to warrant immediate implementation.

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PREFACE

This report documents the development and preliminary assessment of a learning strategy training program. Research was accomplished under Project 1121, Advanced Technology for Air Force Technical Training. Dr. Marty R. Rockway was the Project Scientist, Dr. Gerard Deignan was the Task Scientist until 1 June 1974, and Dr. Ronald Spangenberg was the Task Scientist from 1 June 1974 to the present. Research contained in this report was conducted under the provisions of Contract Number F41609-74-C-0013 with Texas Christian University, Institute for the Study of Cognitive Systems, Fort Worth, Texas, 76129. Dr. Donald F. Dansereau was the Principal Investigator. This research is based upon work reported under the present contract F41609-74-C-0013 in AFHRL-TR-74-70, Learning Strategies: A Review and Synthesis on the Current Literature, and upon previous work performed by the contractor under Contract Number F41609-73-C-0023. This previous work resulted in the publication of AFHRL-TR-73-51(I), Factors Related to Developing Instructional Information Sequences: Phase I, and AFHRL-TR-51(II), Factors Relating to the Development of Optimal Instructional Information Sequences.

The contributions of knowledge and time made by numerous individuals in the local communities and academic environs impelled the development and successful completion of this research. Cooperation of Dr. James Baerwald, Psychology Department, University of Texas at Arlington and Drs. Howard Clark and Larry Wise, Texas Wesleyan College in recruitment of student subjects was deeply appreciated. The excellent combined coordination and cooperation of the Texas Christian University Psychology Department Faculty, Dr. Virginia Jarratt, Harris School of Nursing, Dr. Jo James, School of Education, Dr. W. E. Tucker, Graduate Dean-Religion, and Dr. W. L. Reed, Dean of Undergraduate Religion in encouraging student participation played an important role in completing this training program.

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INTRODUCTION

In this section of the report we will discuss the rationale of the research program by comparing teaching versus learning manipulations with regard to their educational impact. Following this discussion, we will present a brief overview of the research program.

Teaching Versus Learning Manipulations

Educational research and development efforts have been directed almost exclusively at the improvement of teaching. This relative neglect of the learning aspect of education is probably unwarranted; especially when one considers the importance of ameliorating the transfer of classroom knowledge and skills to the job situation.

Attempts at seeking improved teaching methods without consideration of learner strategies have been plagued with difficulties. First, there seems to be very little evidence for the differential effectiveness of distinct methods of instruction. Dubin & Taveggia (1968), in an extensive review of the educational literature, concluded that there is no difference among very distinct college teaching techniques as measured by student performance on final examinations. With regard to more specific teaching manipulations, Dansereau and others (1974) (a), for example, reviewed the literature related to the effect of instructional sequencing on comprehension and retention. According to their review, even comparisons of random versus logical sequences of programmed learning material reflect little or no differences in subsequent performance.

An exclusive focus on teaching methods not only has the potential of being virtually ineffective but also may lead to inadvertent reinforcement of inappropriate and non-transferable learning strategies. For example, many approaches to teaching implicitly encourage rote memorization, a strategy which may inhibit the integration of information with other parts of the memory system. A lack of integration can severely limit the facility with which such information is retrieved in contexts different from the original learning situation. Such a strategy could substantially retard the transfer of knowledge to a job setting.

Education, by not stressing learning strategies, may discourage students from developing and exploring new strategies, and in so doing limit the students' awareness of their cognitive capabilities. This problem becomes critical when there is a mis-match between a learner's strategy and his capabilities. Most of us know individuals who spend inordinate amounts of time memorizing college or high school level materials and are still barely "getting by." Such an individual's personal, intellectual, and social development must certainly suffer from the pressures created by this type of situation.

In summary, exclusive emphasis on teaching methods may lead to ineffective instructional manipulations, may force students to develop non-transferable and inefficient strategies, may limit a student's cognitive awareness, and may, consequently, extract a large emotional toll from the student. Clearly, educators and researchers should re-direct at least some of their efforts to the development and training of appropriate learning strategy skills. The experimental program to be described in this report is a step in this direction.

Before outlining the structure of the present program, we will provide a brief overview of the basis of learning strategy development. While the focus on teaching methods stems directly from the behavioristic influences that pervaded psychology up until the mid-1950's, the potential for improving learning arises from the developments associated with cognitive psychology. As opposed to behaviorism, the cognitive approach emphasizes the role of the organism's "covert" manipulations of the incoming stimuli in predicting responses. Since the early 1960's, the cognitive approach has replaced behaviorism as the dominant school of thought in experimental psychology. As is usually the case, applied research and development lags behind basic research. Presently there is a large amount of information available from basic cognitive studies that needs to be translated into the educational domain. Much of this information relates to learning strategies, when they are defined as methods of selecting, storing, manipulating, managing, and outputting information. A previous report (Dansereau and others, 1974) has reviewed and synthesized

the recent developments in the educational and psychological literature potentially related to the creation and training of effective learning strategies. This review and synthesis has provided a basis for the development of the research.

Structure of the Research Program

The present project has identified potentially effective learning strategies, developed methods of teaching these strategies to students, and assessed the effectiveness of the strategy training using academic-like materials. The identification of effective strategies was accomplished by using information gathered from the previously cited literature review and from an analysis of responses to an extensive self-report inventory (Learning Strategy Inventory). This self-report inventory which is described in Dansereau and others, 1975, was designed to examine potential strategies uncovered by our review of the research literature.

Following identification of potential strategies, considerable effort was devoted to developing methods of training students to utilize the identified strategies. The first informal examination of these training methods took place in the context of a pilot study. Based on the findings of this pilot work, the training materials and procedures were modified and extended. The resulting training program was then assessed formally.

DEVELOPMENT OF THE STRATEGY TRAINING PROGRAM

In this section of the report we will describe the strategies selected for training, the overall structure of the training program, the stimulus materials for each aspect of the program, a brief review of the pilot study, and the revisions in the stimuli and procedures that resulted from this pilot work.

Strategies Selected for Training

Persons required to learn material must be able to identify the important, difficult, and unfamiliar portions of the material, apply techniques appropriate to the comprehension and retention of this material, and subse-

quently retrieve the material under appropriate circumstances. Further, if these processes are to flow efficiently, the individual must be able to cope with internal and external distractions (that is, he must be able to concentrate). Reponses to the Learning Strategy Inventory (see Dansereau and others, 1975) and anecdotal reports indicate that students could benefit from training on all four of the aspects mentioned above. Also, the recent literature related to strategies indicates that effective techniques for dealing with these aspects of learning do exist. Therefore these four processes were incorporated into a coherent, integrated strategy training program. The components of which will now be elaborated.

Identification of Important, Difficult, and Unfamiliar Portions of the Material

Data from the Learning Strategy Inventory responses suggest that better students perceive themselves as reading more flexibly. That is, the presumably alter their reading rates depending on the importance, difficulty, and familiarity of the material. In order to read or study flexibly, a student must first be able to accurately judge the importance, difficulty, and familiarity of the material with which he is dealing. Accurate identification of those portions of academic material that require more careful reading and/or studying should lead to more effective use of study time. To aid the student in making these decisions, a set of instructions and experiences on producing and using "understanding" ratings were developed for use in the training program.

Carroll (1966), Danks (1969), and Schwartz, Sparkman, & Deese (1970) have used "comprehensibility" or "understanding" ratings in a variety of approaches to reading research. It can be concluded from these studies that the subject-produced "understanding" ratings are highly related to reading rates, readability as measured by word and sentence counts, and comprehension as measured by standard reading tests. It would seem then that giving students experience in rating their "comprehensibility" or "understanding" of small segments of text would assist them in deciding which material requires

further reading or studying. A nine point self-report scale reflecting both degree of understanding and anticipated degree of future recall was developed for this purpose.

Techniques Appropriate to the Comprehension and Retention of Information

The Learning Strategy Inventory results indicated that students, especially poorer students, often bypass or memorize material that they have difficulty understanding. One reason for this ineffective approach to learning may be the lack of effective strategies in the students' repertoires. If so, training students to use appropriate learning techniques should improve academic performance. This aspect of the training process has formed the cornerstone of our training program.

Difficulties in comprehension and retention of academic material probably stem from at least two sources. First, many students tend to receive information passively and consequently do not actively integrate it into their existing cognitive structures (this integration process is surely a prerequisite for "true" understanding). Second, many students apparently do not attempt to produce multiple memory representations (that is, encodings) of the same material in order to enhance retrieval (especially in contexts that differ from the original learning situation). If these suppositions are correct it seems reasonable to train students to actively encode information (that is, put it in a form that is compatible with their memory systems) after a segment of material has been listened to or read.

The active integration of information into an individual's cognitive structure has been considered in the basic educational and psychological research literature under the rubric of mathemagenic behavior. The mathemagenic concept was created by Rothkopf (1966) and is literally interpreted as behaviors which give birth to learning. The research that has been done in this area has provided a basis for developing the comprehension and retention techniques

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used in the present program. Also contributing to the development of these techniques has been research resulting from recent emphasis in cognitive psychology on memory encoding (see Melton & Martin, 1972, for a sampling of this work). The most direct contributions of this area have come from research on mnemonics (for example, Bower, 1973) and visual imagery (for example, Paivio, 1971). Both of these bodies of research support the notion that multiple encodings are more effective for subsequent retrieval than single encodings.

Three techniques were developed for the enhancement of comprehension and retention: the question-answer connection technique, the paraphrase connection technique, and the imagery connection technique. Each of these three techniques and their associated training procedures will be discussed separately.

The question-answer connection technique. This technique evolves directly from studies assessing the mathemagenic utility of questions inserted before, after, or within textual material. A large number of investigations (for example, Frase, 1968; Hershberger & Terry, 1964; Rothkopf & Bisbicos, 1967) have shown that if students are given a chance to review experimenter-generated questions it seems to facilitate comprehension and retention, and that this enhancement is greater when questions are placed after the material to which they refer. Further, different types of questions apparently can have different effects: "high level" analysis and evaluation questions seem to prompt more thorough study and cognitive reorganization, while factual questions influence only attention to facts (Hunkins, 1968). To date, research on these issues has dealt exclusively with experimenter-generated questions (primarily a teaching manipulation). Why not train students to generate and answer their own "high level" questions after short segments of text (primarily a learning manipulation)? One aspect of the present training program is designed to do just that.

The following steps for question-answer connection training were employed in the pilot study (subsequent modifications of these steps were made for the formal assessment study, see "Modifications of the Training Program for the Formal Study" section.

1. The subject was made aware of the general nature of the question-answer technique, and the prior research supporting the effectiveness of this technique.

2. To familiarize the student with the types of questions and answers we felt would be effective, he was given experience in determining which parts of an experimenter-generated question and answer corresponded to the portions of a paragraph from which the question and answer was constructed. Further, to give the student a framework for constructing his own questions and answers, he was exposed to a number of models of step-by-step constructions of questions and answers produced by the experimenters.

3. The student then went through a series of trials in which he read a paragraph, created his own question and answer, which presumably captured the main idea of the paragraph, and then checked his question and answer against one generated by the experimenters as an example of a correct application of the question-answer connection technique. A large number of unrelated paragraphs varying in content and comprehensibility were used in this exercise.

4. In the next phase, the student encountered two related paragraphs in succession. He was required to form a question and answer to the first paragraph, and where possible, expand and modify that question and answer to include the material presented in the second paragraph. This practice on developing more complex and inclusive questions and answers was again supported by experimenter-generated feedback.

5. In this section of the program the student was again required to expand and modify questions and answers to include later material. Rather than just pairs of related paragraphs the material in this phase consisted of multi-paragraph articles extracted from Scientific American. This task presumably most closely approximated tasks facing the student in real-world academic situations.

The paraphrase connection technique. The development of this technique is supported by the research of Bauman & Glass (1969), Gay (1971), and Ausubel & Youseff (1965). Their findings indicate that experimenter generated summary-like reviews and organizers enhance comprehension and retention. Again, analogous to our extrapolations from the questioning research, the notion pursued in the present program was the training of students to produce their own summaries in the form of paraphrases. The training steps involved with the paraphrase connection technique are directly analogous to those described in conjunction with the question and answer technique. In fact, the same stimulus material was used in both cases.

The imagery connection technique. Paivio (1969, 1971) and many others have reported that concrete verbal material and/or instructions to form visual images lead to better performance (when compared with appropriate control groups) in tasks using serial lists, paired associates, and sentences. One of the next steps in determining the potential of imagery for enhancement of the academic learning process would be the extension of the "instructions to image" research into the domain of prose material beyond the level of the sentence. To make this step, extensive training, not merely instructions to image, is probably required. The aspect of the present research program under discussion has been designed to do this. Again, the steps in training are directly analogous to those outlined in the discussion of the question and answer technique, and the stimulus materials used are identical. The only difference is that after reading a paragraph the student is asked to draw or verbally describe the visual image he has created to capture the main ideas of the material. Feedback occurs in the form of experimenter-generated drawings.

The three techniques discussed: question-answer, paraphrase, and imagery, comprise our attempts at improving the second phase of the learning process: comprehension and retention of the identified material. For the purposes of the pilot and formal studies these techniques were taught separately to different groups of students and the resulting performances were compared. However, it is probably true that these techniques are

differentially effective depending on the type of material the student is dealing with (concrete material may be most easily dealt with by the imagery technique, etc.). Thus, in future work, a student should probably be trained in all three techniques and given guidelines on when to employ them. Further information on this issue will be presented in the discussion of the results of the formal assessment study.

Techniques Appropriate to the Retrieval of Stored Information

The third phase of the learning process that we have identified as requiring improvement is that of retrieval. Subjective reports from students and studies demonstrating "tip of the tongue" behavior (Brown & McNeill,1966), and "feeling of knowing" (Hart, 1965) indicate that stored items are frequently available, but at least temporarily, not accessible. When an individual encounters such a situation he may give up, randomly search, or attempt to execute a systematic retrieval strategy. It appears that students often opt for the first two alternatives rather than the third. This is unfortunate in that systematic attempts at retrieval often lead to success. Lindsay & Norman (1972) give a brief example of how this approach works. In response to the query: "What were you doing on Monday afternoon in the third week of September two years ago?", Lindsay & Norman's imaginary subject gradually homes in on the answer by breaking the query down into a rational sequence of subquestions that prove answerable by various mixtures of actual memories and logical reconstructions of what must have been ("Third week in September - that's just after summer - that would be the fall term...I think I had chemistry lab on Mondays... I remember he started off with the atomic table...,etc.").

It was felt that students could benefit from instruction on how to undertake a systematic retrieval and from experience in actually using such an approach in retrieving information that was not immediately accessible. Therefore, a portion of the training program was designed to serve these purposes. The instruction on retrieval strategies consisted of discussions on when to attempt retrieval, what types of cues or connections could be effectively used in retrieval (both

incidental and organizational cues were described), and what steps should be taken during retrieval activity. This last category consisted of a description of the following six steps.

1. When faced with information that is not immediately accessible try to think of other information which is logically or incidentally connected to the target information.

2. On the basis of how much connected information you can think of, and your general feelings about whether you know the target material, make a decision as to whether to attempt retrieval or not.

3. If you are going to attempt retrieval, use the connected information to form subquestions which seem reasonable to you.

4. As you answer some of the subquestions, use this information, if necessary, to develop new subquestions.

5. Continue the above step until you either find the information or feel that you are running out of new leads, in which case it may be time to stop.

6. After a vigorous, but unsuccessful, effort to retrieve a piece of information, it is often useful to go on to something else and return to the effort later.

The entire discussion of retrieval was laced with examples and anecdotes in order to make the information concrete. Since retrieval training came prior to training on the three connection techniques, frequent efforts were made to communicate to the students that retrieval could be facilitated by making certain that a large number of connections were attached to the material during learning. This hopefully set the stage for the subsequent portions of the training program.

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Following the presentation of strategy information, students were then asked to try to retrieve information on questions that presumably would be difficult to access (for example, "When did the Cuban missle crisis occur?"). The student was asked to follow the procedures we had outlined and write down his thoughts during retrieval. After his attempt he was given the verbal protocol of an imaginary student attempting the same retrieval in order for him to see at least one systematic path to the target information. Three such experiences were included in the pilot work and four in the formal study.

Experience in Coping with Distractions During Learning

The last phase of the learning process that we will deal with is really a meta-phase in that it contributes to or detracts from effectiveness of the other three phases. Responses to the Learning Strategy Inventory indicated that poorer students have substantial difficulties concentrating on academic materials. Perhaps these students, and many "good" students in addition, have not had the opportunity for coping effectively with distractions. During actual studying they may be too goal oriented for such development to take place. It is hypothesized that subjecting students to gradually increasing external distraction while they are attempting to comprehend and retrieve academic materials may assist them in developing strategies for blocking out such distractions. Further, it is suggested that such strategies may be generalizable to internally produced distractions.

Three levels of auditorily presented distractions (loudness was maintained within the bounds of normal speech) increasing in variety and interest value were successively imposed on students reading academic material (two Scientific American passages of 1,000 and 500 words per distraction condition in the pilot study). Since this experience occurred following the training on the three connection techniques (question-answer, imagery, and paraphrase), the students had the opportunity to practice their newly acquired skills in the context of a distraction task. It was expected that the active processing involved in forming connections would aid concentration (as opposed to typical passive reading strategies) and would, there-

fore, further demonstrate to the student the utility of these connection techniques.

The Pilot Study

An informal pilot study was conducted to assess the procedures, instructions, stimuli, and dependent measures developed in conjunction with the strategy training program. A substantial amount of information relevant to potential program modifications was gained from this study. In general, the overall reaction to strategy trainings was very favorable and the criticisms raised were constructive. A brief description of the major modifications that were instituted prior to the formal study will be presented in the next section.

Modifications of the Training Program for the Formal Study

The following changes were implemented on the basis of the findings of the pilot experimentation.

General

The training sessions were shortened and resequenced to avoid differential degrees of fatigue and proactive inhibition. Also, the continuity of the instructions was improved (greater expression of relationships between parts of the program resulted from this smoothing) and more attention to motivating factors was provided.

Connection Technique Training

The students in the pilot study felt that connection technique training was somewhat ambiguous and was not reaching its potential level of effectiveness. Therefore, much effort went into revising the instructions and stimulus materials for this part of the program. Generally, these revisions involved emphasizing the creation of unusual or bizarre connections and the creation of shorthand connections. The first direction was based on the results of the experimental literature on mnemonic devices showing the facilitating effects of

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bizarreness (Persensky & Senter, 1970) and the assumption that forming unusual connections would be more enjoyable hence more motivating than the creation of standard connections. The second direction was based on the reactions of pilot subjects indicating that they felt the act of fully writing out the connections was far too time consuming. Finally, a third modification approach involved greater emphasis on the formation of cumulative connections. The results of these modifications will be described more thoroughly in the method section of the Formal study.

Concentration Experience

Post-treatment ratings of the distractability of the tapes used during the concentration experience indicated that our a priori ordering of the distractions was not entirely accurate. A replacement tape was created for one of the tapes in order to bring the ordering of distractions in line with the subjective experiences of the pilot subjects. In addition, it was decided to increase the volume on each of the tapes three times during the course of their use (again, the volume was kept within the bounds of normal speech). This volume increase was done to add even further gradations to the levels of distraction in order to provide the student with even greater opportunities for adaptation. Finally, the time constraints imposed on the formal study forced the concentration experience to be reduced to one 1,000 word passage per distraction condition.

Training Assessment Tests

The Training Assessment Test was expanded from three to four 1,000 word passages. The fourth one was presented under moderate auditory distraction. Again, after reading all four passages the students were given 20 questions per passage (80 total questions).

Individual Difference Measures

In the formal study a relatively large number of subjects per condition were included in the experiment (approximately 22-25) in order to allow for the assessment of individual differences in responsiveness to

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the strategy training. A self-report Imagery Scale (Dansereau, 1969), the Delta Vocabulary test (Deignan, 1973) and Rotter's Internal-External (Rotter, 1966) scale were administered to the subjects to provide a basis for such an analysis.

THE FORMAL ASSESSMENT STUDY

The purposes of the formal study were as follows.

1. To determine if exposure to the protypical strategy training program would result in better comprehension and retention of academic-like materials than that accomplished by a no-treatment control group.

2. To determine if there would be differences in performance associated with the utilization of the three different connection techniques (question-answer, paraphrase, and imagery).

3. To determine the impact of individual differences on training program effectiveness.

Although many educators and researchers have expressed the desirability of study skills training courses, very few formal evaluations of the effectiveness of such courses have been undertaken. Briggs, Tosig & Morely (1971) found that study skill training led to significantly higher grade point average (than a no-treatment control group) on the part of a group of "high risk" college students. Brown and others (1971) and Haslam & Brown (1968) found that Brown & Holtzman Survey of Study Habits and Attitudes scores increased as a function of participation in a study skills training program.

The impact of these few notable exceptions is limited for a number of reasons. The context of these courses has usually been restricted to standard study techniques such as the SQ3R method (Robinson, 1946). These techniques are not derived from basic empirical findings. They focus on one phase of the learning process, and they do not offer optional paths for students differing in cognitive ability and style. The present prototype training program offers potential remediation of all the above mentioned deficiencies.

Due to the paucity of prior research in this area no formal hypotheses were developed. It was expected, however, that the treatment groups would perform better than the control group, especially on measures of long term retention. There were, however, no a priori expectations of the ordering of performance between the three connection technique treatment groups. All three techniques were derived from effective manipulations suggested by basic research, and no previous formal comparisons between the techniques have been published. In any case, it was anticipated that the effectiveness of these treatments would interact with the individual difference measures.

Method

One hundred undergraduates at Texas Christian University were recruited from General Psychology classes and the Harris School of Nursing to serve as subjects in this experiment. The students were given experimental participation credit and were paid a fixed fee of $8.00 each for their service.

The subjects were randomly assigned to one of four groups (25 subjects per group). Three of these groups were given the training experiences described previously. The only difference between these three groups was in their connection technique training. One group received the question-answer technique, another the paraphrase technique, and the third the imagery technique. The fourth group, the no-treatment control group, was given no formal training except that necessary to allow them to complete the dependent measures. Three members of the control group did not complete all of the required dependent measures, so, members of each of the three treatment groups were dropped randomly for balancing.

The three treatment groups were trained and tested in four sessions. The first session lasted approximately 2 hours and 30 minutes, the second session 2 hours and 10 minutes, the third session 2 hours and the fourth session 50 minutes (a total of approximately 7 hours and 30 minutes). The control group's participation was limited to three sessions lasting 35 minutes, 2 hours, and 40 minutes, respectively (a total of approximately 3 hours and 15 minutes).

The content and sequence of steps involved in administering the training and testing components of the program to the three treatment groups are illustrated in Figure 1. These steps can be described briefly as follows.

1. A general introduction to the nature of the training program and the purposes of the study was presented (3 minutes).

2. The Delta Vocabulary test was administered (10 minutes, see Deignan, 1973).

3. Instruction and practice on making "understanding" judgments was provided (20 minutes) see Dansereau, 1974.[1]

4. The students were then given training on when and how to systematically retrieve temporarily inaccessible material from memory (45 minutes, see Dansereau, 1974).

5. The three treatment groups were separated for instruction on their connection techniques. The groups were treated as identically as possible; each was given exactly the same sequence of training steps. These steps consisted of: (a) an introduction to the connection technique, (b) experience in relating parts of an experimenter generated connection to the original material from whence it came, (c) experience in following the step-by-step constructions of experimenter generated connections, (d) experience in forming connections to independent paragraphs with experimenter developed connections serving as feedback, (e) instructions on forming memorable (unusual and bizarre) connections, (f) experience in forming memorable connections to

[1]Dansereau, D. F. "Understanding Material" Unpublished experimental papers, Institute for the Study of Cognitive Systems (ISCS), Texas Christian University, 1974.

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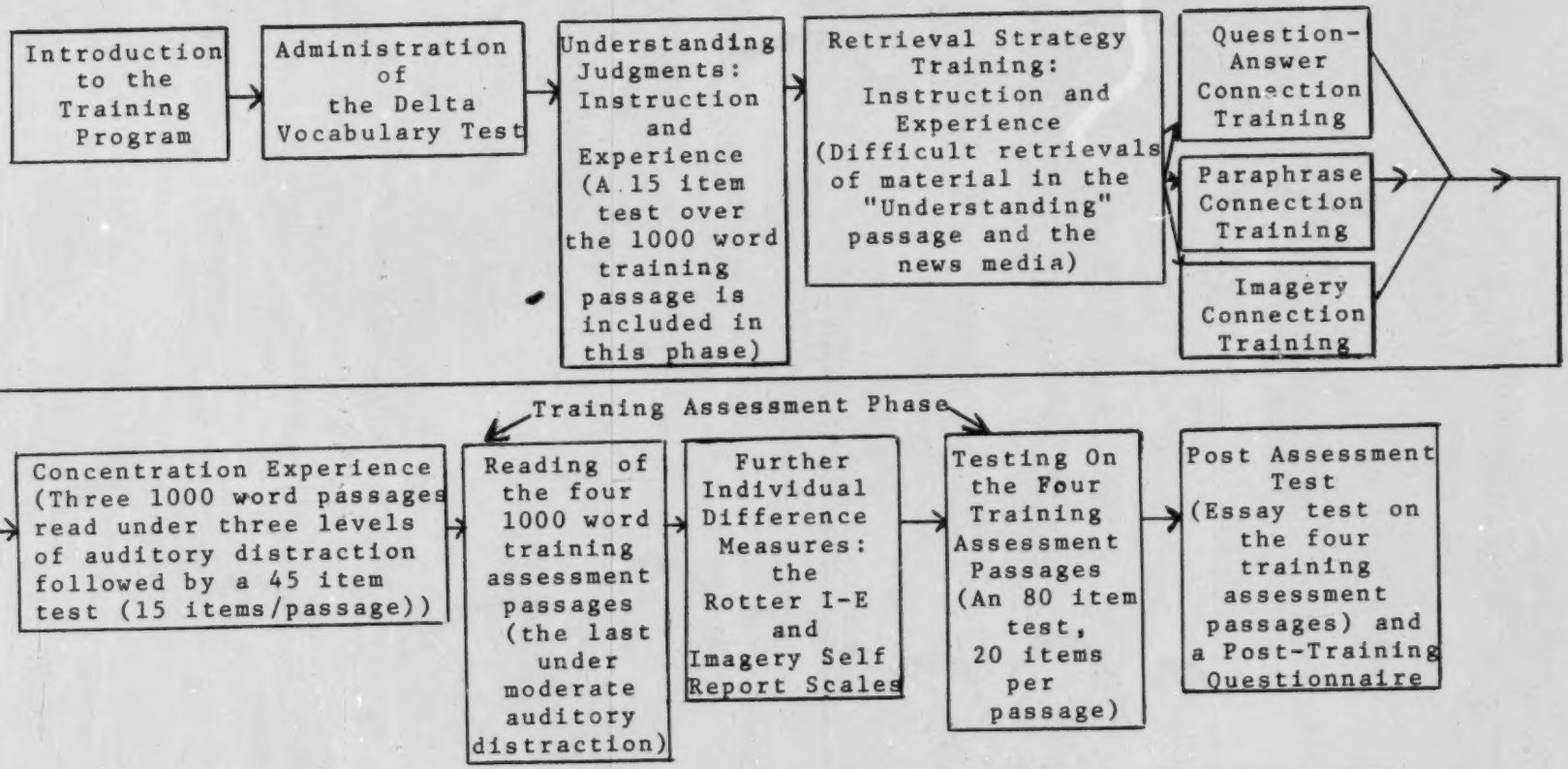
Introduction to the Training Program
Administration of the Delta Vocabulary Test
Understanding Judgments: Instruction and Experience (A 15 item test over the 1000 word training passage is included in this phase)
Retrieval Strategy Training: Instruction and Experience (Difficult retrievals of material in the "Understanding" passage and the news media)
Question-Answer Connection Training
Paraphrase Connection Training
Imagery Connection Training
Training Assessment Phase
Concentration Experience (Three 1000 word passages read under three levels of auditory distraction followed by a 45 item test (15 items/passage))
Reading of the four 1000 word training assessment passages (the last under moderate auditory distraction)
Further Individual Difference Measures: the Rotter I-E and Imagery Self Report Scales
Testing On the Four Training Assessment Passages (An 80 item test, 20 items per passage)
Post Assessment Test (Essay test on the four training assessment passages) and a Post-Training Questionnaire

Control Group (not shown in the schematic) received the Introduction to the Training Program, the Delta Vocabulary Test, Understanding Judgment Training, the Training Assessment Phase, the Individual Differences Measures and the Post Assessment Test.

Formal Assessment Study: Schematic of the Training Program Treatments

Figure 1

independent paragraphs (training to this point lasted about 60 minutes and marked the end of the first experimental session), (g) instructions on forming cumulative connections, (h) experience on forming memorable, cumulative connections to pairs of related paragraphs, (i) instructions on forming "shorthand" or abbreviated connections, (j) experience in forming memorable, cumulative, shorthand connections to pairs of related paragraphs, (k) instructions on when to use the connections technique (based on the "understanding" rating), and (l) experience in forming memorable, cumulative, shorthand connections to a series of related paragraphs (1,000 word Scientific American article segments) while making decisions concerning when the technique should be employed. The total time for the connection training was approximately 2 hours and 15 minutes (see Dansereau et al, 1975 for a presentation of the stimulus and testing material used in this training).

6. Following connection training, the three treatment groups were brought together for the remainder of the program. They were next given concentration experience in which they were instructed to read, rate (understanding), and apply their connection technique to material in three 1,000 word passages (12 minutes per passage was allowed). This processing was accompanied by taped auditory distractions increasing in volume, interest value, and variability. Nine levels of distractions were presented: each of three tapes varying in interest value and variability were presented at three different volumes. After completing all three passages, the subjects were given a 45 item test composed of True-False, multiple-choice, fill in the blank, and short answer questions. The total time involved in the concentration experience was approximately 55 minutes and marked the end of the second experimental session (see Dansereau, 1974[2]).

7. The subjects were then required to read four, 1,000 word training assessment passages while making

[2]Dansereau, D. F. "Concentration Experience" Unpublished experimental papers, ISCS, Texas Christian University, 1974.

understanding ratings and, where applicable, applying their connection technique (13 minutes per passage was allowed). The last of these passages was accompanied by a moderately distracting tape (volume was not varied). Total time provided was approximately 60 minutes (see Dansereau, 1974[3]).

8. After reading the four passages, the subjects responded to Rotter's Internal-External Scale (10 minutes) and a self-report Imagery Scale (10 minutes). See Dansereau, 1969, Deignan, 1973, and Rotter, 1966 for copies of these scales.

9. The subjects were then given an 80-item test (multiple choice, true-false, fill in the blank, and short answer questions) over the four passages read in Step 7 (35 minutes were provided), see Dansereau, 1974[4]. This marked the end of the third experimental session.

10. Five days after the third session, the subjects were given a set of essay questions over the four passages read in Step 7 (40 minutes). See Dansereau, 1974[5] for a presentation of the test items.

11. They were then asked to fill out an anonymous questionnaire (only their connection technique group affiliation was identified) reflecting their opinions on aspects of the training program (15 minutes). This ended the fourth and final experimental session (see Appendix A).

The Control group was given appropriately modified versions of Steps 1, 2, 3, 7, 8, 9, and 10. During reading the control subjects were required to make "Understanding" ratings. Also, the processing times allowed were the same for all four groups.

[3]Dansereau, D. F. "Concentration Experiences" Unpublished experimental papers, ISCS, Texas Christian University, 1974.

[4]Dansereau, D. F. "Training Assessment: Passages and Test" op. cit.

[5]Dansereau, D. F., "Post Assessment Test" op. cit.

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Results of the Formal Study

The analyses presented in this section will be divided into four subcategories: those dealing with the understanding ratings, the comprehension and retention measures, the post-training questionnaire results, and the individual difference measures. For convenience the means and standard deviations of all dependent measures for each of the four groups are presented in Appendix B.

The Understanding Ratings

All subjects were required to make approximately 5 understanding ratings (on a 1-9 scale) per passage. To provide a basis for analyzing these ratings, the 5 judgments were averaged to arrive at a mean understanding rating for each passage. These mean passage ratings were then correlated with scores on the corresponding passage tests for each of the four groups separately. Subsequently, crude averages of the correlations relating to a particular aspect of the program (that is, concentration experience and training assessment) were calculated. These correlations along with those for the "understanding" experience are presented in Table 1. As can be seen, the correlations presented in Table 1 are relatively low (only three of the eleven are significant at the .05 level). This is somewhat surprising in that prior research has indicated a relatively strong relationship between self reports of understanding and comprehension test scores. However, this discrepancy is perhaps due to the fact that prior work has looked at understanding ratings within the same subject, not between subjects as is represented in Table 1. Naturally, due to individual differences in use of the rating scale, you would expect lower correlations when they are based on between subject data. Also, the groups receiving strategy training used their understanding ratings as a basis for deciding when to apply the connection technique. This usage probably biased the ratings to some degree and consequently lowered the correlations.

These factors, in addition to the lack of observed differences between the group understanding rating means, negated the use of the understanding ratings as a sensitive supplementary measure of comprehension. Consequently, no further analyses of these ratings were conducted.

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TABLE 1

Crude Average Correlations Between Passage Scores and Their Associated Mean Understanding Ratings**

Groups	"Understanding" Experience (4 passages)	Concentration Experience (3 passages)	Training Assessment (4 passages)
Paraphrase	.42*	.16	.18
Imagery	.46*	.17	.24
Question-Answer	.13	.34*	.24
Control	.21	--	.28

* Indicates $p < .05$

** The entries in this table are the average of the passage correlations; each correlation is based on 22 data points.

The Comprehension and Retention Measures

The scoring of all of the passage tests was done in a "blind" fashion (that is, experimental group affiliation was not available to the scorer) using highly structured scoring keys. A total score, calculated for each subject on each test, served as the basic dependent measure.

A two way Analysis of Variance with repeated measures on the "passage" factor was used to analyze the data resulting from the "concentration experience" groups (question-answer, paraphrase, and imagery; the control group did not receive the concentration experience) served as levels of one factor, while the three passages read under different levels of distraction served as levels of the other (the means tested by the analysis are presented in Table 2). The results of the Analysis of Variance indicated that the effect due to the passage factor was significant ($F=29.0$ (2,132 d.f.), $p < .001$), and that the "groups" effect and the interaction effect were not (the F ratios were both slightly less than 1).

The effect due to passages is not of any real interest since distraction level and passage content are confounded. It was included in the analysis primarily to determine if there was an interaction

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between groups and passages. Therefore, no post hoc testing of the passage factor was conducted.

TABLE 2

Mean Concentration Passage Test Scores for the Three Treatment Groups

Groups	Concentration Passages			
	Low Distraction	Medium Distraction	High Distraction	Total
Paraphrase Connection	10.77	7.37	9.54	27.68
Imagery Connection	10.42	7.29	9.21	26.92
Question-Answer Connection	9.23	7.06	8.98	25.27

A second two way Analysis of Variance with repeated measures on the "passage factor was used to analyze the data resulting from the "training assessment." The four groups (question-answer, paraphrase, imagery, and control) served as the levels of one factor, while the four training assessment passages served as the levels of the other (the means tested by the analysis are presented in Table 3). The results of the Analysis of Variance indicated that the effect due to the passage factor was significant ($F=60.7$ (3,276 d.f.), $p<.001$) and that the "groups" and interaction effects were not. Again, the passage factor was included mainly for its potential contribution to an interaction effect and was therefore not subjected to further analysis.

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TABLE 3

Mean Training Assessment Passage Test Scores for the Four Experimental Groups

Groups	Training Assessment Passages*				Total
	1	2	3	4	
Paraphrase	13.92	11.66	10.28	9.20	45.06
Imagery	13.15	11.33	9.56	9.46	43.50
Question-Answer	12.71	11.52	9.65	8.79	42.67
Control	12.45	9.91	8.76	7.82	38.94

* $p < .001$

A one way Analysis of Variance was conducted for the four groups on the post-training assessment test scores (the means for this analysis are represented in Table 4). The effect of groups was significant ($F=3.6$ (3,84 d.f.), $p < .025$). A Tukey's multiple comparison test indicated that the control group differed significantly from the imagery and paraphrase groups at the .05 level, while all other comparisons between means were non-significant. As can be seen in Table 4, the paraphrase and imagery groups (and to a somewhat lesser extent, the question-answer group) had substantially higher levels of mean performance than did the control group (over 55% greater performance in the case of the paraphrase group). This finding indicates that the strategy training program had a very strong positive effect on the longer term retention of academic-like materials. Of course, a "placebo effect" explanation for this finding is possible, but can be substantially discounted in light of the lack of significant differences in the training assessment Analysis of Variance. One would have to ask why a "placebo effect" didn't show up on these measures also.

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The main reason for consideration of a "placebo" explanation is the lack of significant differences between the three training groups across the three Analyses of Variance. But, although non-significant, the differences between the mean levels of performance for the three groups are highly consistent, in all cases paraphrase, imagery, question-answer (see Tables 2,3, and 4). Perhaps if our dependent measures were more sensitive, these consistent differences would reach significance. Further support for the existence of actual training related differences between these groups is provided by analysis of the post-training questionnaire.

TABLE 4

Mean Post-Training Assessment Scores for the Four Experimental Groups

Groups	Means Test Scores
Paraphrase	28.42
Imagery	27.23
Question-Answer	25.56
Control	18.29

The Post-Training Questionnaire

All subjects receiving strategy training anonymously completed the questionnaire exhibited in Appendix A (the only identification they placed on the questionnaire was their group affiliation: paraphrase, question-answer, or imagery). In order to facilitate the extraction of information from this instrument, the responses to questions 4, 5, 6, 7, 8, and 14 were collapsed for each of the three groups as a measure of the general perceived value of the connection technique. Questions 1, 2, 3, and 13 were

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collapsed to form a measure of the perceived utility of the connection techniques during distraction. Finally, questions 9, 10, and 11 were collapsed to form a measure of perceived effectiveness of the retrieval training. The categories of responses for each of the above measures were dichotomized into positive (very much so and somewhat) and negative (very little and not at all) responses. The number of responses in each of the categories for each measure are presented in Tables 5, 6, 7.

TABLE 5

Frequencies With Which Individuals in the Training Groups Perceived the General Value of Their Connection Techniques as Positive or Negative *

Group	Positive	Negative
Paraphrase	121	29
Imagery	101	40
Question-Answer	82	67

* All differences of significance at the .001 level

TABLE 6

Frequencies With Which Individuals in the Training Groups Perceived Their Concentration as Positive or Negative While Using the Connection Techniques *

Group	Positive	Negative
Paraphrase	50	50
Imagery	27	67
Question-Answer	24	72

* All differences of significance at the .001 level

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TABLE 7

Frequencies With Which Individuals
in the Training Groups
Perceived the Value of the
Retrieval Training as Positive or Negative

Group	Positive	Negative
Paraphrase	66	9
Imagery	56	16
Question-Answer	58	16

Pearson Chi Square tests for independence were run on Tables 5, 6, and 7. Table 5, general value of the connection technique, was significantly dependent at the .001 level (X^2 = 23.6, 2 d.f.). Table 6, value of the connection technique under distraction, was also significantly dependent at the .001 level (X^2 = 15.8, 2 d.f.), while Table 7, value of the retrieval training, was not significant (X^2 = 3.2, 2 d.f.).

The results just discussed should be interpreted with caution since the tables were not composed of entirely independent observations. In any case, inspection of the three tables shows that the paraphrase group felt most positive about their connection technique, both generally and under distraction (Tables 5 and 6) while the imagery groups was second, and the question-answer group third. Remember, this is exactly the same ordering as was found for the means on all three sets of dependent measures (Tables 2, 3, and 4).

The possibility that these differences are due to general "yea saying" on the part of the paraphrase group are partially negated by the lack of differences in Table 7. All three groups apparently felt the retrieval training was equally valuable.

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The Individual Differences Measures

The individual difference measures (the Delta Vocabulary test, the Imagery Self Report Scale, and the Rotter's Internal-External Scale) were administered to all subjects participating in the formal assessment study. The intercorrelations between these three measures over our subject populations were extremely low (none of the correlations were close to reaching significance). The correlations for each of these measures with the comprehension and retention dependent measures are presented on a group by group basis in Tables 8 through 11. Of the three measures only the Delta Vocabulary test was consistently related to the dependent measures at a significant level. This finding adds further empirical support for the use of the Delta test as an economical, but potent measure of individual differences in academic situations.

Examination of the correlations in Tables 8 through 11 indicates relatively little in the way of systematic differences between the four treatment groups. Therefore, further analyses of these correlations were not undertaken at this time. Rather, the scores on the three individual difference measures were used to subdivide the groups; the resulting factors were then included in a series of Analyses of Variance.

Three two way Analyses of Variance were calculated with the sum of the three concentration passage test scores serving as the dependent measure. In all three analyses one of the factors was the training groups (paraphrase, imagery, and question-answer) and the other was a high-low split (11 subjects per cell) based on one of the three individual difference measures. The analysis with "groups" and high and low Delta as the factors resulted in a significant effect of Delta Vocabulary grouping ($F=57.9$ (1,60 d.f.), $p < .001$). However, neither the effect of "groups" (as was expected from previous analyses) nor the effect of the interaction was significant (both F ratios were slightly less than 1).

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TABLE 8

Paraphrase Connection Group: Correlations Between the Passage Scores and the Individual Difference Measures

Passage Scores	Individual Difference Measures		
	Imagery Scale	Delta Test	Rotter Scale
"Understanding" Passage Score	-.19	.75*	-.38*
Concentration: Low Distraction Score	-.35*	.69*	-.39*
Concentration: Medium Distraction Score	.17	.65*	-.22
Concentration: High Distraction Score	-.28	.62*	-.42
Training Assessment: Passage 1 Score	-.56*	.62*	-.35*
Training Assessment: Passage 2 Score	-.34*	.45*	-.22
Training Assessment: Passage 3 Score	-.39*	.70*	-.17
Training Assessment: Passage 4 Score	-.13	.71*	-.24
Post Training Assessment Score	-.36*	.62*	-.37*

24 Data Points Per Correlation

* Indicates $p < .05$

TABLE 9

Imagery Connection Group: Correlations Between the Passage Scores and the Individual Difference Measures

Passage Scores	Individual Difference Measures		
	Imagery Scale	Delta Test	Rotter Scale
"Understanding" Passage Score	.11	.69*	-.15
Concentration: Low Distraction Score	-.12	.53*	-.06
Concentration: Medium Distraction Score	.02	.46*	-.13
Concentration: High Distraction Score	-.01	.58*	-.15
Training Assessment: Passage 1 Score	.13	.40*	-.27
Training Assessment: Passage 2 Score	.23	.77*	-.02
Training Assessment: Passage 3 Score	.02	.69*	-.04
Training Assessment: Passage 4 Score	.00	.66*	.17
Post Training Assessment Score	-.33	.58*	.25

24 Data Points Per Correlation

* Indicates $p < .05$

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TABLE 10

Question-Answer Connection Group: Correlations Between The Passage Scores and the Individual Difference Measures

Passage Scores	Individual Difference Measures		
	Imagery Scale	Delta Test	Rotter Scale
"Understanding" Passage Score	.25	.71*	-.16
Concentration: Low Distraction Score	.25	.61*	-.18
Concentration: Medium Distraction Score	-.14	.70*	-.04
Concentration: High Distraction Score	.00	.24	-.29
Training Assessment: Passage 1 Score	.02	.45*	-.28
Training Assessment: Passage 2 Score	-.20	.35*	-.06
Training Assessment: Passage 3 Score	.25	.56*	.16
Training Assessment: Passage 4 Score	.21	.53*	-.18
Post Training Assessment Score	.23	.46*	-.21

24 Data Points Per Correlation

* Indicates $p < .05$

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TABLE 11

Control Group: Correlations Between the Passage Scores and the Individual Difference Measures

Passage Scores	Individual Difference Measures		
	Imagery Scale	Delta Test	Rotter Scale
"Understanding" Passage Score	.07	.49*	.11
Concentration: Low Distraction Score	--	--	--
Concentration: Medium Distraction Score	--	--	--
Concentration: High Distraction Score	--	--	--
Training Assessment: Passage 1 Score	.00	.41*	-.34*
Training Assessment: Passage 2 Score	.06	.64*	.06
Training Assessment: Passage 3 Score	-.04	.47*	-.13
Training Assessment: Passage 4 Score	.06	.23*	.24
Post Training Assessment Score	-.03	.67*	.16

24 Data Points Per Correlation

* Indicates $p < .05$

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As was anticipated from the correlations analysis, inspection of the means presented in Table 12 indicates that the high Delta scorers performed substantially better than the low Delta scorers on the "concentration experience" passages.

TABLE 12

Mean Total Performance
on the Concentration Passage Tests
for the Three Training Groups
and the Two Delta Test Sub-Groups

Groups	Delta Test Sub-Groups*	
	High Scorers	Low Scorers
Paraphrase	32.91	20.14
Imagery	32.41	21.50
Question-Answer	30.14	18.91

* $p < .001$

The two-way analysis with "groups" and high and low imagery as the factors resulted in no significant effects (all F ratios were slightly less than one). However, the analysis with "groups" and the Rotter scale division (Internals versus Externals) as factors did result in a significant effect due to the Rotter division ($F=4.1$ (1,60 d.f.), $p < .05$). Again, the other two effects (groups and interaction) were non-significant. Inspection of the means in Table 13 indicates that Internals outperformed the Externals on the "concentration experience" passages. This result marks an interesting extension of the Rotter scale into a previously unexplored domain.

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TABLE 13

Mean Total Performance
on the Concentration Passage Tests
for the Three Training Groups
and the Two Rotter Sub-Groups

Groups	Rotter Scale Sub-Groups*	
	Internals	Externals
Paraphrase	29.86	23.64
Imagery	28.82	25.23
Question-Answer	25.82	23.23

* $p < .05$

Analogously, three more two-way Analyses of Variance were calculated with the sum of the training assessment passage test scores serving as the dependent measure. In these analyses all four experimental groups (paraphrase, imagery, question-answer, and control) were included as the levels of one factor, while the other factor was defined by each of the three individual difference measures in the same way as described in the previous paragraphs. The only significant effect resulting from these three analyses was that due to high and low Delta. Again, inspection of the means in Table 14 indicates that high Delta scorers performed substantially better than low scorers.

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TABLE 14

Mean Total Performance
on the Training Assessment Passage Tests
for the Four Experimental Groups and
the Two Delta Test Sub-Groups

Groups	Delta Test Sub-Groups*	
	High Scores	Low Scores
Paraphrase	50.64	34.64
Imagery	50.09	36.72
Question-Answer	46.82	37.45
Control	44.45	34.32

* $p < .001$

Finally, three additional two-way Analyses of Variance were calculated with the post-training assessment score serving as the dependent measure. The factors were again experimental groups and individual difference measure sub-groupings. In all three analyses the effect of "groups" was significant at or beyond the .05 level. This is not surprising in light of previous analyses with the post-training assessment test (ses Table 4). The only other effect to reach significance was the high-low Delta division. The means in Table 15 again reflect the higher comprehension and retention performance attained by high Delta scorers.

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TABLE 15

Mean Total Performance on the
Post Training Assessment Test
for the Four Experimental Groups
and the Two Delta Sub-Groups

Groups	Delta Test Sub-Groups**	
	High Scores	Low Scores
Paraphrase	37.36	18.91
Imagery	32.36	23.00
Question-Answer	30.27	18.64
Control	22.84	13.73

** $p < .001$

Discussion of the Formal Study Results

This section of the report contains a discussion of the effect of training on comprehension and retention, an assessment of the effectiveness of the connection techniques, an evaluation of the identification, concentration, and retrieval aspects of the program, and a discussion of the individual difference measures.

The Effect of Training on Comprehension and Retention

The training groups (paraphrase, imagery, and question-answer) did not perform significantly better than a "no treatment" control group on the immediate training assessment test, but strongly out performed the control subjects on the post-training measure (in particular, the paraphrase group's performance was 55% better than that of the control group's on this delayed measure). The training assessment and post-training assessment measures differed in two ways. The training

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assessment measure consisted of true-false, multiple choice, fill in the blank, and short answer questions, and was administered approximately 30 minutes after the reading of the four passages. On the other hand, the post-training measure was composed of essay type questions and was administered 5 days after the passages had been read. Obviously, this confounding of the factors of time and question type prevents us from drawing a definite conclusion as to the locus of the training effect. Is the pattern of results due to improved long term retention on the part of the training groups, or improved retrieval capabilities when faced with general questions (essay-type), or a combination of both? Clearly another experiment is necessary to separate out these possibilities. Type of test questions and delay of testing need to be counterbalanced in order to determine which capability or combination of capabilities is being improved by training.

Of course, we cannot overlook the possibility that none of the above explanations apply and that the strongly significant differences on the post-training measure are due to a "placebo" effect. This explanation is somewhat compelling in light of the fact that there were no significant differences between the three treatment groups on any of the measures taken. However, there are a number of factors that negate the possibility of such a "placebo" effect. First, why wasn't there a "placebo" effect on the training assessment test? Why would it occur only on the post-training measure. Second, although there were no significant differences between the three training groups, there were strong consistent differences on both of the training assessment measures as well as the concentration experience measure. The paraphrase group consistently produced the highest level of performance, the imagery group second, and the question-answer third. Further, this pattern of differences was dramatically supported by post-training questionnaire results which indicated the paraphrase subjects valued their technique most highly, the imagery second, and

the question-answer third. This set of circumstances would perhaps imply that training group differences would appear if the sensitivity of our dependent measures were increased. If this situation did occur, as it seems it would, the "placebo" explanation would be rendered impotent.

One final comment with regard to the "placebo" effect is in order. It should be noted that with respect to training assessment studies the "placebo" possibility becomes little more than a technical objection. It is virtually impossible to arrive at a "placebo" control group in these circumstances. About the only possibility is to give a group training on techniques that the experimenters a priorily consider to be ineffective or counterproductive. Any such techniques would certainly not have face validity for the students and would, consequently, not provide a motivational boost comparable to that provided by face valid approaches. There fore, even employing such a procedure would not adequately control for "placebo" effects.

Finally, if training does improve performance it probably should not matter if a component of that improvement is due to "placebo-like" causes. Improvement in academic achievement is difficult enough to come by without quibbling over its basis.

In summary, the training program leads to substantial improvements in performance on a long term measure of comprehension and retention. Further, attempts to attribute this improvement to "placebo" effects can be substantially discounted. It can be concluded, therefore, that the present training program has proven to be effective and that prospects for implementation should be considered.

Assessment of the Effectiveness of the Connection Techniques

The first question to be dealt with in this

subsection is why were the performance differences between training and control subjects not greater, especially on the training assessment test (Table 3). Obviously, the degree of difference is directly related to the sensitivity of the dependent measures. Additional measures should be developed for more accurate assessment.

A number of potential deficiencies in the training program may have limited the range of treatment-control differences. These potential deficiencies were identified primarily through analysis of the post-training interviews.

1. A number of subjects reported they felt that the connection technique they were taught was incompatible with their normal modes of information processing. This perceived incompatibility, which apparently was most pronounced in the imagery group, seemed to make acquisition and utilization of the techniques very difficult for some subjects. In future studies subjects should probably be given exposure to all of the connection techniques and then be allowed to choose the one that they feel most comfortable with for further training. Besides increasing the compatibility aspect, this approach would probably enhance motivation via a reduction in cognitive dissonance. Perhaps an even more fruitful extension of this approach would consist of training subjects on all of the connection techniques to criterion and then allowing them to employ the techniques at their discretion. Since the techniques may be differentially applicable to different types of material (for example, the imagery technique may be particularly useful with concrete materials) and since alternation of the techniques may allow for use of both the visual and verbal memory systems, it seems reasonable to further train students to intermittently shift techniques based on content and memory conditions.

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2. In addition to raising questions about incompatibility, the responses to the questionnaire indicated that a number of students felt that they had not learned their techniques to a sufficient degree. They apparently felt that the application of the techniques was not automatic enough, and thus, required too much conscious effort and too much time. This criticism can probably be eliminated by extending the training over longer periods.

3. A corollary to the above criticism is the notion that the training was too intensive. The pace of training was extremely rapid, and the techniques required a great deal of overt responding. This situation led to frustration and fatigue on the part of many subjects and apparently, at least in some cases, this frustration and fatigue carried over to the testing sessions. Again, extending the training over longer periods would presumably reduce the intensity, and thus, eliminate this problem.

4. Subjects may have been required to utilize their techniques too frequently (that is, over segments of material that were not sufficiently large) for maximum efficiency. If the segments of material are too small the subject may be spending an inordinate amount of time forming connections to relatively unimportant aspects of the information. A study which varies the amount of material covered before technique application would provide information on the optimal frequency of connection formation.

5. Finally, the techniques themselves may need to be refined in order to enhance treatment-control differences. In the next few paragraphs we will more fully explore this notion.

The paraphrase technique is probably most compatible with students' normal modes of processing. Its relative success may in fact be due largely to this compatibility. In the present training program

paraphrase was defined very loosely, both via instruction and feedback. An acceptable paraphrase could range from a simple re-stating of the presented material in different words to a total re-organization and integration of the material. We had hoped that actual subject behavior would tend toward the latter end of this continuum. However, this did not prove to be the case. In the future the paraphrase technique requirements should be narrowed and explicit training on re-organization and integration with prior knowledge should be provided.

The question-answer technique had much in common with the paraphrase technique, in fact the answers to the questions provided as feedback during training were identical to the paraphrases that were used as feedback. As we conceived of them, the only difference between the two techniques was that in using the question-answer approach, a general orienting question was asked before a paraphrase (answer) was constructed. Performance on the dependent measures indicated that the question-answer technique was consistently the least successful of the three. Therefore, it appears that the asking of an orienting question prior to paraphrasing does not aid comprehension and retention and probably exerts a negative influence on performance.

As mentioned earlier, many of the students receiving imagery connection training felt that this approach was incompatible with their normal ways of dealing with information. In spite of this, the performance of the imagery group was consistently better than that of the question-answer group and almost as good as that of the paraphrase group. In fact it appears from Table 15 that for persons scoring poorly on the Delta Vocabulary test the imagery technique may be even more effective than the paraphrase strategy. These results combined with highly positive attitudinal responses from some of the imagery subjects are very encouraging. Since visual imagery may not be readily available in most students' repertoires, a greater amount of connection training

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supplemented by some basic imagery exercises is probably required before this technique can reach its full potential. Also, allowing students to select their own technique would eliminate some of the problems associated with forcing individuals with low imagery ability and/or preference into using this technique.

An Evaluation of the Identification, Concentration, and Retrieval Aspects of the Program

The understanding rating which served as an identification process and supplementary dependent measure in the formal study did not appear to be very successful in either role. Refinement and amplification of this approach will be necessary in future experimentation.

The concentration experience did not lead to better performance by the training groups on the fourth training assessment passage (this passage was read under a moderate level of distraction). This lack of an effect is far from conclusive evidence that the concentration experience failed to aid overall performance, but it at least does lead to the conclusion that this "experience" should be subjected to a very severe evaluation in future studies. Students' reactions to the experience were mixed, as were perhaps the benefits received. In light of some of their comments, it might be very useful to incorporate meditation or relaxation training into the concentration experience in order to make coping with external and internal distractions less problematic.

Students' reactions to the retrieval training aspect of the program were extremely favorable. Unfortunately a direct test of its effectiveness was not possible within the constraints of this study. In future work the retrieval training should be tested separately, but even if its effectiveness cannot be directly demonstrated it should perhaps be retained for its subjective value to participating students.

The Individual Difference Measures

The imagery self report questionnaire was virtually unrelated to any of the other dependent or individual difference measures. Factors created by dividing subjects on the basis of this questionnaire were non-significant across all analyses. Within the context of the formal study this measure appeared to have no utility whatsoever. This of course does not mean that imagery ability itself is not of importance. In fact, a factor analysis of a variety of imagery measures conducted by DiVesta, Ingersoll, & Sunshine (1971) showed that subjective reports of imagery ability were not very highly related to objective measures of this same ability. In the future, attempts should be made to develop a short, objective measure of imagery capabilities and preference for use in modified versions of the training program.

As would be expected from previous studies (for example, Dansereau, and others, 1974,) the Delta Vocabulary test proved to be strongly predictive of performance on all the dependent measures. Because it takes only ten minutes to administer, the authors strongly urge its adoption as a supplement to presently existing diagnostic and prediction systems.

The final individual difference measure used in the study was Rotter's Internal-External scale (Rotter, 1966). The concept underlying this scale refers to the degree of control the person judges that he has over his environment. The person at the "internal" end of the continuum perceives outcomes to be a consequence of his own actions. The person at the "external" pole believes that outcomes are due to fate, luck, and powerful others, and therefore, are beyond his personal control. Prior work with this scale has shown that internals, as compared with externals, more actively seek information relevant to problem solving (Davis & Phares, 1967), tend to retain more information when this information is relevant to personal goals (Seeman, 1963),

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and tend to better utilize information that has been equivalently acquired and retained by internals and externals (Phares, 1968).

The findings of the present study indicate that internals perform significantly better in comprehending and retaining information presented under distraction, but do not differ from externals when similar information is presented without distraction. It appears that internals, although not superior in "normal" comprehension and retention ability, are substantially better able to cope with distractions. This finding dramatically extends the growing body of literature oriented around the Internal-External scale into a new domain, and clearly deserves replication under more direct experimental manipulations. If a replication is successful, then effort should be directed toward assessing the utility of this easily administered scale as a predictor of success in jobs which require information processing within distracting environments.

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATION

Prior educational research has been directed almost exclusively at the development and assessment of potentially effective teaching manipulations. We have argued that this exclusive emphasis on teaching often may lead to ineffective instructional manipulations, may force students to develop inefficient and non-transferable learning strategies, may limit a student's cognitive awareness, and may, consequently, extract a large emotional toll from the student. On the basis of these arguments, it has been recommended that at least some of the educational research effort be redirected toward the development, training and assessment of effective learning strategy skills. The present research project was undertaken to provide a step in this direction.

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This project has involved three basic steps: the identification of potentially effective and trainable learning strategies, the development of methods for teaching these strategies to students, and the assessment of the effectiveness of the strategies and training in the context of academic-like tasks.

The identification of effective strategies has been accomplished by using information gathered from a review of the educational and psychological research literature dealing with strategies, and from an analysis of responses to the specially developed Learning Strategy Inventory. The results of research with the Inventory indicated that students could be profitably trained on four aspects of the learning process: the identification of important, unfamiliar, and difficult material, the application of techniques for the comprehension and retention of this identified material, the efficient retrieval of this information under appropriate circumstances, and the effective coping with internal and external distractions while these other processes are being employed. In addition, the Inventory findings suggest that if properly modified the Learning Strategy Inventory could more generally serve as a diagnostic and predictive device in academic settings.

After the four areas of needed improvement were identified, specific strategies relating to each of these aspects were extrapolated from the educational and psychological literature. The process of applying techniques for enhanced comprehension and retention was believed to be most critical, and consequently, three alternative comprehension and retention techniques or strategies were extrapolated (paraphrasing, question-answering, and the use of visual imagery). Methods of training the strategies related to the four aspects of the learning process were developed and combined in an integrated, prototypical training program.

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An informal assessment of this program was conducted in the context of a pilot study. Three groups of students were given the strategy training program; the only difference between these groups was in the type of comprehension and retention technique with which they were provided (paraphrase, question-answer, or imagery). A fourth group did not receive training, but was asked to respond to the dependent measures. On the basis of the results of this study, the training program was extensively modified and streamlined.

This modified program was then tested in a formal assessment study which utilized the four subject groupings described earlier. Individual difference measures were also included in this study in order to assess differential reactions to training. The results of this study indicated that the training program dramatically improved long term retention of academic-like material. On one dependent measure, the training groups performed at a level that was approximately 55% higher than that of the control group. Consistent differences between the three training groups indicated that the paraphrase and imagery techniques should undergo further refinement and testing, while the question-answer technique should be dropped from future consideration. Important supplementary findings arose from analyses of two of the individual difference measures: the Delta Vocabulary test and Rotter's Internal-External scale. The Delta test proved to be an excellent predictor of performance on the academic-like dependent measures and should be incorporated into academic achievement prediction systems. The Rotter scale proved to be extremely predictive of performance on academic tasks involving external distraction and consequently, should be used as a selection device for jobs requiring information processing in distracting settings.

In summary, this project has proven to be very successful, an effective strategy training program has been created, modified and assessed.

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We feel that this present training program is sufficiently effective to warrant immediate implementation, however, on the basis of our experiences during the assessment phase of this project we have developed the following set of recommendations for improving the quality of training.

1. The training experience should be extended over a longer time period in order to enhance the acquisition of the specific techniques and to reduce the frustration and fatigue associated with intensive exposure to the program.

2. The frequency with which the connection techniques are applied should be manipulated in order to arrive at an optimal frequency for an individual or set of individuals.

3. The paraphrase technique can be improved by training the student to reorganize the target material, and, where possible, to integrate this material with his prior knowledge.

4. The student should be trained on both the paraphrase and imagery connection techniques and then trained to intermittently shift techniques depending on content and memory conditions.

5. Relaxation and/or meditation training should be employed to enhance the concentration experience.

6. The retrieval training phase of the program was not tested but was extremely well received by the students. This phase warrants amplification and assessment.

In addition to the above recommendations regarding training, it is also suggested that the efficiency of using the Rotter scale as a predictor of success in tasks requiring information processing under distraction be further explored.

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Appendix A

Post Training Questionnaire

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LEARNING STRATEGIES TRAINING:
POST-QUESTIONNAIRE

Do not put your name on this document.
Please circle which of the following
connection techniques you were given:

imagery

question-answer

paraphrase

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(1) Did you find the first tape presented during concentration training distracting?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments (Would you please include what you can remember of this tape):

(2) Did you find the second tape presented during concentration training distracting?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments (Would you please include what you can remember of this tape):

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(3) Did you find the third tape presented during concentration training distracting?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments (Would you please include what you can remember of this tape):

(4) Did you use the connections formed by your technique in attempting to remember information necessary to answer the test questions?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(5) Do you think the connection technique was useful to you in the testing sessions?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(6) Do you think that you will use your connection technique in studying for courses:

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

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(7) Do you feel that you became better at using the technique as you practised it more:

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(8) Do you think other students would benefit from using your connection technique:

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

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(9) Did you learn anything useful from the retrieval training session?

(a) very much
(b) some
(c) very little
(d) nothing at all

Comments:

(10) Did you use the techniques presented during retrieval training in the testing sessions?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(11) Will you use the retrieval techniques in future courses?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(12) Did the concentration training help you to increase your ability to concentrate?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

(13) In comparison to "straight" reading, did you feel better able to concentrate when you were using your connection technique?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(14) Do you think studying will be more enjoyable when you are using your connection technique?

(a) very much so
(b) somewhat
(c) very little
(d) not at all

Comments:

(15) Do you feel you need further practice with your connection technique?

(a) a large amount
(b) some
(c) very little
(d) none

Comments: (If appropriate please indicate which kind of practice would be helpful).

(16) Which tape played during concentration training was the most distracting

(a) 1 (Behavioral Objectives)
(b) 2 (Beyond the Horizon)
(c) 3 (Marat de Sade)

(17) Which tape played during concentration training was the least distracting

(a) 1 (Behavioral Objectives)
(b) 2 (Beyond the Horizon)
(c) 3 (Marat de Sade)

Appendix B

Measures and Standard Deviations on all Dependent Measures for all Four Groups

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Imagery Connection Group:

Performance on the Dependent

and Individual Difference Measures

Items	Mean	Standard Deviation
Understanding Rating Experience		
1. "Understanding Rating" Passage Score (15 Items)	9.87	3.33
2. Mean Understanding Rating for the Above Passage (1-9)	6.23	1.38
(The above exercises were given to all groups prior to training)		
Concentration Experience		
3. Low Distraction Passage Score (Concentration, 15 Items)	10.42	2.85
4. Mean Understanding Rating for the Above Passage (1-9)	6.06	1.00
5. Medium Distraction Passage Score (Concentration, 15 Items)	7.29	3.27
6. Mean Understanding Rating for the Above Passage (1-9)	5.73	1.40
7. High Distraction Passage Score (Concentration, 15 Items)	9.21	3.24
8. Mean Understanding Rating for the Above Passage (1-9)	5.81	1.36

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Imagery Connection Group (continued)

Items	Mean	Standard Deviation
Training Assessment		
9. 1st Training Assessment Passage Score (20 Items)	13.15	2.51
10. Mean Understanding Rating for the Above Passage (1-9)	5.43	1.25
11. 2nd Training Assessment Passage Score (20 Items)	11.33	3.60
12. Mean Understanding Rating for the Above Passage (1-9)	5.36	1.40
13. 3rd Training Assessment Passage Score (20 Items)	9.56	3.04
14. Mean Understanding Rating for the Above Passage (1-9)	5.59	1.34
15. 4th Training Assessment Passage (Moderate Distractions) Score (20 Items)	9.46	2.48
16. Mean Understanding Rating for the Above Passage (1-9)	5.49	1.21
Post Training Assessment		
17. Post Assessment Test Score (Essay Format)	27.23	9.11
Individual Difference Measures		
18. Imagery Scale	73.38	8.52
19. Delta Vocabulary Test	31.29	7.62
20. Rotter's Internal-External Scale	11.88	4.24

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Question-Answer Connection Group:

Performance on the Dependent

and Individual Difference Measures

Items	Mean	Standard Deviation
Understanding Rating Experience		
1. "Understanding Rating" Passage Score (15 Items)	10.08	3.19
2. Mean Understanding Rating for the Above Passage (1-9)	6.45	1.31
(The above exercises were given to all groups prior to training)		
Concentration Experience		
3. Low Distraction Passage Score (Concentration, 15 Items)	9.23	3.01
4. Mean Understanding Rating for the Above Passage (1-9)	5.36	1.37
5. Medium Distraction Passage Score (Concentration, 15 Items)	7.06	2.96
6. Mean Understanding Rating for the Above Passage (1-9)	4.77	1.89
7. High Distraction Passage Score (Concentration, 15 Items)	8.98	3.52
8. Mean Understanding Rating for the Above Passage (1-9)	5.51	1.77

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Items	Mean	Standard Deviation
Training Assessment		
9. 1st Training Assessment Passage Score (20 Items)	12.71	2.85
10. Mean Understanding Rating for the Above Passage (1-9)	5.75	.947
11. 2nd Training Assessment Passage Score (20 Items)	11.52	3.82
12. Mean Understanding Rating for the Above Passage (1-9)	5.30	1.48
13. 3rd Training Assessment Passage Score (20 Items)	9.65	3.20
14. Mean Understanding Rating for the Above Passage (1-9)	5.76	1.25
15. 4th Training Assessment Passage (Moderate Distractions) Score (20 Items)	8.79	2.84
16. Mean Understanding Rating for the Above Passage (1-9)	4.351	1.94
Post Training Assessment		
17. Post Assessment Test Score (Essay Format)	25.56	9.97
Individual Difference Measures		
18. Imagery Scale	69.38	13.53
19. Delta Vocabulary Test	29.58	7.51
20. Rotter's Internal-External Scale	12.04	4.17

Paraphrase Connection Group:

Performance on the Dependent

and Individual Differences Measures

Items	Mean	Standard Deviation
Understanding Rating Experience		
1. "Understanding Rating" Passage Score (15 Items)	9.96	3.36
2. Mean Understanding Rating for the Above Passage (1-9)	5.90	1.24
(The above exercises were given to all groups prior to training)		
Concentration Experience		
3. Low Distraction Passage Score (Concentration, 15 Items)	10.77	2.97
4. Mean Understanding Rating for the Above Passage (1-9)	5.71	1.49
5. Medium Distraction Passage Score (Concentration, 15 Items)	7.37	2.86
6. Mean Understanding Rating for the Above Passage (1-9)	5.57	1.44
7. High Distraction Passage Score (Concentration, 15 Items)	9.54	.41
8. Mean Understanding Rating for the Above Passage (1-9)	5.80	1.45

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Paraphrase Connection Group (continued)

Items	Mean	Standard Deviation
Training Assessment		
9. 1st Training Assessment Passage Score (20 Items)	13.92	2.98
10. Mean Understanding Rating for the Above Passage (1-9)	5.75	1.37
11. 2nd Training Assessment Passage Score (20 Items)	11.66	3.93
12. Mean Understanding Rating for the Above Passage (1-9)	5.39	1.48
13. 3rd Training Assessment Passage Score (20 Items)	10.28	3.62
14. Mean Understanding Rating for the Above Passage (1-9)	5.46	1.19
15. 4th Training Assessment Passage (Moderate Distractions) Score (20 Items)	9.20	3.50
16. Mean Understanding Rating for the Above Passage (1-9)	5.04	1.62
Post Training Assessment		
17. Post Assessment Test Score (Essay Format)	28.42	14.61
Individual Difference Measures		
18. Imagery Scale	69.24	11.25
19. Delta Vocabulary Test	30.28	7.29
20. Rotter's Internal-External Scale	11.44	3.96

Control Group:

Performance on the Dependent

and Individual Difference Measures

Items	Mean	Standard Deviation
Understanding Rating Experience		
1. "Understanding Rating" Passage Score (15 Items)	8.96	2.79
2. Mean Understanding Rating for the Above Passage (1-9)	6.36	1.42
(The above exercises were given to all groups prior to training)		
Concentration Experience		
3. Low Distraction Passage Score (Concentration, 15 Items)		
4. Mean Understanding Rating for the Above Passage (1-9)		
5. Medium Distraction Passage Score (Concentration, 15 Items)		
6. Mean Understanding Rating for the Above Passage (1-9)		
7. High Distraction Passage Score (Concentration, 15 Items)		
8. Mean Understanding Rating for the Above Passage (1-9)		

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Control Group (continued)

Items	Mean	Standard Deviation
Training Assessment		
9. 1st Training Assessment Passage Score (20 Items)	12.45	3.58
10. Mean Understanding Rating for the Above Passage (1-9)	5.59	1.66
11. 2nd Training Assessment Passage Score (20 Items)	9.91	4.52
12. Mean Understanding Rating for the Above Passage (1-9)	4.62	1.33
13. 3rd Training Assessment Passage Score (20 Items)	8.76	3.29
14. Mean Understanding Rating for the Above Passage (1-9)	4.97	1.28
15. 4th Training Assessment Passage (Moderate Distractions) Score (20 Items)	7.82	3.31
16. Mean Understanding Rating for the Above Passage (1-9)	3.65	1.34
Post Training Assessment		
17. Post Assessment Test Score (Essay Format)	18.29	10.50
Individual Difference Measures		
18. Imagery Scale	72.61	8.15
19. Delta Vocabulary Test	28.70	7.62
20. Rotter's Internal-External Scale	12.13	3.27